General

Title

Sepsis: proportion of hospitalized children younger than 19 years of age identified as having sepsis syndrome who had a blood culture drawn within 4 hours of meeting diagnostic criteria for the condition.

Source(s)

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC). Basic measure information: timely blood culture for children with sepsis syndrome. Ann Arbor (MI): Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium; 2014 Aug. 46 p.

Measure Domain

Primary Measure Domain

Clinical Quality Measures: Process

Secondary Measure Domain

Does not apply to this measure

Brief Abstract

Description

This measure is used to assess the proportion of hospitalized children younger than 19 years of age identified as having sepsis syndrome who had a blood culture drawn within 4 hours of meeting diagnostic criteria for the condition. A higher proportion indicates better performance.

Rationale

Sepsis is a potentially catastrophic condition that can escalate from infection to organ failure and death within hours. While mortality rates for pediatric sepsis have decreased over time, 4% to 10% of hospitalized children with sepsis in the United States die (Watson et al., 2003; Odetola, Gebremariam, & Freed, 2007). Also, annual hospital treatment costs are significant, at nearly $2 billion (Watson et al., 2003). Clinical practice parameters and clinical guidelines for the treatment of children with sepsis syndrome emphasize the critical importance of early recognition and aggressive treatment for all suspected cases of pediatric sepsis syndrome (Dellinger et al., 2013; Carcillo et al., 2002); improved

survival has been associated with adherence to guidelines that emphasize timeâ€sensitive resuscitation of children with sepsis syndrome (Han et al., 2003). Whether a child presents to an academic medical center or a community hospital, clinicians must be ready to rapidly deploy a set of timeâ€sensitive, goalâ€directed, stepwise procedures to hinder or reverse the cascade of events in sepsis that lead to organ failure and death. One essential element of timely and appropriate treatment is the blood culture. Promptly obtaining a blood culture to identify the invading pathogen helps clinicians determine an effective antimicrobial regimen. Because guidelines strongly recommend that children immediately receive a broad spectrum antibiotic, blood cultures should be drawn shortly after the patient presents to the hospital. However, administration of an antibiotic should not be unduly delayed to obtain the culture.

Evidence for Rationale

Carcillo JA, Fields AI. Clinical practice parameters for hemodynamic support of pediatric and neonatal patients in septic shock. Crit Care Med. 2002 Jun;30(6):1365-78. [162 references] PubMed

Dellinger RP, Levy MM, Rhodes A, Annane D, Gerlach H, Opal SM, Sevransky JE, Sprung CL, Douglas IS, Jaeschke R, Osborn TM, Nunnally ME, Townsend SR, Reinhart K, Kleinpell RM, Angus DC, Deutschman CS, Machado FR, Rubenfeld GD, Webb SA, Beale RJ, Vincent JL, Moreno R, Surviving Sepsis Campaign Guidelines Committee including the Pediatric Subgroup. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2012. Crit Care Med. 2013 Feb;41(2):580-637. [636 references] PubMed

Han YY, Carcillo JA, Dragotta MA, Bills DM, Watson RS, Westerman ME, Orr RA. Early reversal of pediatric-neonatal septic shock by community physicians is associated with improved outcome. Pediatrics. 2003 Oct;112(4):793-9. PubMed

Odetola FO, Gebremariam A, Freed GL. Patient and hospital correlates of clinical outcomes and resource utilization in severe pediatric sepsis. Pediatrics. 2007 Mar;119(3):487-94. PubMed

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC). Basic measure information: timely blood culture for children with sepsis syndrome. Ann Arbor (MI): Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium; 2014 Aug. 46 p.

Watson RS, Carcillo JA, Linde-Zwirble WT, Clermont G, Lidicker J, Angus DC. The epidemiology of severe sepsis in children in the United States. Am J Respir Crit Care Med. 2003 Mar 1;167(5):695-701. PubMed

Primary Health Components

Sepsis syndrome; blood culture; children

Denominator Description

The eligible population for the denominator is the number of hospitalized children younger than 19 years of age with sepsis syndrome (See the related "Denominator Inclusions/Exclusions" field).

Numerator Description

The eligible population for the numerator is the number of hospitalized children younger than 19 years of age with sepsis syndrome who had a blood culture drawn within 4 hours of meeting diagnostic criteria for this condition (See the related "Numerator Inclusions/Exclusions" field).

Evidence Supporting the Measure

Type of Evidence Supporting the Criterion of Quality for the Measure

A clinical practice guideline or other peer-reviewed synthesis of the clinical research evidence

A formal consensus procedure, involving experts in relevant clinical, methodological, public health and organizational sciences

One or more research studies published in a National Library of Medicine (NLM) indexed, peer-reviewed journal

Additional Information Supporting Need for the Measure

Sepsis Prevalence and Incidence
While sepsis-associated mortality in children has declined in recent years, from 97% in infants in 1966 to 9% in the early 1990s, it remains a major cause of morbidity and mortality among children (Watson et al., 2003). Incidence of pediatric sepsis was estimated in 1995 to be 0.56/1000 children, with the highest prevalence in infancy at 5.6/1000 children; boys had a higher incidence compared with girls (0.6 vs. 0.52 per 1000 children) (Watson et al., 2003). Sepsis prevalence tends to have two peaks during childhood, corresponding to significant periods of time in the maturity of the immune system: first, during the neonatal stage, with an incidence of 4.3 per 1000 and second, at 2 years of age (Watson et al., 2003). Odetola et al. (2007) reported another age-specific peak in hospitalization rates: in 2003, children 15 to 19 years of age made up 18% of the pediatric population hospitalized nationally for sepsis.

Mortality among hospitalized children with severe sepsis has been reported to be between 4% and 10% (Watson et al., 2003; Odetola, Gebremariam, & Freed, 2007). Mortality is strongly associated with multiple organ dysfunction syndrome, occurring in 7% of children with one failing organ and increasing to 53% in those with at least four failing organs (Watson et al., 2003). Comorbid illness is also associated with mortality from sepsis, with mortality rates of 8% in children with comorbid illness versus 2% among previously healthy children (Odetola, Gebremariam, & Freed, 2007). There are also reports of age-specific differences in mortality from pediatric sepsis. Higher mortality rates among children over the age of 2 years may be attributable to the presence of chronic and severe underlying disease and to improved survival of immune-compromised and immuneâ€suppressed children (Oliveira et al., 2008). Also, older pediatric patients have been sick longer than younger patients and may also have experienced more hospital admissions and treatments, such as transplantation or chemotherapy, making them more vulnerable to sepsis syndrome (Oliveira et al., 2008).

Sepsis Cost
Estimated annual total cost of pediatric sepsis in the United States is $1.97 billion (Watson et al., 2003). The average (mean) charge per hospitalization for sepsis is $47,126 (Odetola, Gebremariam, & Freed, 2007). Children who died from sepsis had total hospital charges that were 2.5-fold higher compared with those who survived. Higher charges were also associated with higher severity of illness. Longer length of stay for children hospitalized with sepsis was associated with multiple comorbidities, multiple organ dysfunction, and higher illness severity (Odetola, Gebremariam, & Freed, 2007).

Performance Gap
Despite the availability of evidence-based guidelines for the care of children with sepsis, only a minority of children receive the standard of care. Process barriers are a common problem leading to delays in the recognition and treatment of pediatric shock (Cruz et al., 2011). They include varying levels of experience among emergency department staff performing initial evaluations, lack of adequate nursing staff for resource-intensive patients, difficulty in obtaining frequent vital signs, lack of standardization of empiric antibiotics and diagnostic tests, lack of prioritization of medications, and barriers to patient flow through the hospital. Shock protocols, which standardize and facilitate care by providing explicit instructions

regarding interventions and timeframes, allow physicians to intervene earlier and harness resources for very ill children (Cruz et al., 2011).

Many children live far from medical facilities that offer specialized pediatric care. For those presenting with septic shock to local hospitals, treatment efforts made by physicians will be critical to their survival and should be prioritized. Delay in care while waiting to transfer patients to a more advanced pediatric medical facility is unwise (Han et al., 2003). The results of a 9 year retrospective study (Han et al., 2003) indicated that 29% of infants and children who presented with septic shock at community hospitals and required transport to a larger medical center did not survive.

Because the clinical guidelines for the treatment of sepsis were developed at pediatric academic centers without accounting for their use at community hospitals, barriers to use may exist. For example, some community physicians may lack some of the specialized technical skills involved in managing sepsis in critically ill children. Others may be uncomfortable placing central venous catheters in critically ill children. Educational barriers regarding the guidelines themselves may curtail implementation if physicians are unaware or lack support to execute stepwise, goal-directed interventions such as obtaining blood cultures and administering broad-spectrum antibiotics in a timely manner. However, most of the procedures detailed in the guidelines are easily within the scope of a community-based practice (Han et al., 2003). Local physicians are as crucial to the treatment of pediatric sepsis as their counterparts at large academic medical centers; continued efforts to increase knowledge and comfort with sepsis guidelines will improve outcomes. Odetola and colleagues (2007) note an urgent need for concerted clinical and educational efforts within the clinical care setting, designed to limit the progression of sepsis severity. The association found between multiple organ dysfunction and death support such efforts as an important risk reduction strategy.

Despite guideline recommendations for prompt initiation of antimicrobial therapy, delays in intravenous antibiotic therapy of 3.5 hours in survivors and 4 hours in patients who died have been observed (Oliveira et al., 2008). Reasons for delay may include inaccuracy in assessing the severity of a child's state of shock and a shortage of health care providers. An overworked medical team will be less likely to conduct a timely evaluation and institute appropriate treatment in the first hour of response to septic shock (Oliveira et al., 2008). Further, treatment of septic shock cannot start at arrival at the intensive care unit; it must begin when patients present to the emergency department (Larsen, Mecham, & Greenberg, 2011). Early recognition and treatment of septic shock right from presentation to the emergency department benefits all patients because it leads to more meticulous patient assessment (Larsen, Mecham, & Greenberg, 2011).

See the original measure documentation for additional evidence supporting the measure.

Evidence for Additional Information Supporting Need for the Measure

Cruz AT, Perry AM, Williams EA, Graf JM, Wuestner ER, Patel B. Implementation of goal-directed therapy for children with suspected sepsis in the emergency department. Pediatrics. 2011 Mar;127(3):e758-66. PubMed

Han YY, Carcillo JA, Dragotta MA, Bills DM, Watson RS, Westerman ME, Orr RA. Early reversal of pediatric-neonatal septic shock by community physicians is associated with improved outcome. Pediatrics. 2003 Oct;112(4):793-9. PubMed

Larsen GY, Mecham N, Greenberg R. An emergency department septic shock protocol and care guideline for children initiated at triage. Pediatrics. 2011 Jun;127(6):e1585-92. PubMed

Odetola FO, Gebremariam A, Freed GL. Patient and hospital correlates of clinical outcomes and resource utilization in severe pediatric sepsis. Pediatrics. 2007 Mar;119(3):487-94. PubMed

Oliveira CF, Nogueira de SÃi FR, Oliveira DS, Gottschald AF, Moura JD, Shibata AR, Troster EJ, Vaz FA, Carcillo JA. Time- and fluid-sensitive resuscitation for hemodynamic support of children in septic shock: barriers to the implementation of the American College of Critical Care Medicine/Pediatric Advanced Life Support Guidelines in a pediatric intensive care unit in a developing world. Pediatr Emerg Care. 2008 Dec;24(12):810-5. PubMed

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC). Basic measure information: timely blood culture for children with sepsis syndrome. Ann Arbor (MI): Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium; 2014 Aug. 46 p.

Watson RS, Carcillo JA, Linde-Zwirble WT, Clermont G, Lidicker J, Angus DC. The epidemiology of severe sepsis in children in the United States. Am J Respir Crit Care Med. 2003 Mar 1;167(5):695-701. PubMed

Extent of Measure Testing

Reliability

Data and Methods. Measure testing involved an audit of medical records from three large hospitals serving children in Michigan: Children's Hospital of Michigan (CHM, Detroit), Hurley Medical Center (Hurley, Flint), and C.S. Mott Children's Hospital – University of Michigan Health System (UMHS, Ann Arbor). Medical records for all children with sepsis syndrome meeting the measure specification criteria during the measurement year were abstracted at each site. Note that at the University of Michigan, an 18-month measurement period was used (January 1, 2012 to June 30, 2013) to enable an adequate number of eligible records for review. Among the three sites, 300 unique and valid records for children with sepsis syndrome were abstracted and reviewed to test this measure.

Reliability of medical record data was determined through reâ€abstraction of patient record data by a second abstractor to calculate the interâ€rater reliability (IRR) between abstractors. Broadly, IRR is the extent to which the abstracted information is collected in a consistent manner (Keyton et al., 2004). Low IRR may be a sign of poorly executed abstraction procedures, such as ambiguous wording in the data collection tool, inadequate abstractor training, or abstractor fatigue. For this measure, the medical record data collected by two nurse abstractors were compared.

Measuring IRR at the beginning of the abstraction process is imperative to identify and correct any misinterpretations early on. It is also important to assess IRR throughout the abstraction process to ensure that the collected data maintain high reliability standards. Therefore, IRR was evaluated at each site to address any reliability issues prior to completing data abstraction. Lessons learned were applied to work at the other sites.

IRR was determined by calculating both percent agreement and Kappa statistics. While abstraction was still being conducted at each site, IRR assessments were conducted for 5% of the total set of unique patient records that were abstracted. Two abstractors reviewed the same medical records; findings from these abstractions were then compared, and a list of discrepancies was created.

Three separate IRR meetings were conducted, one in the early stages of abstraction for each center. All of the meetings included a review of multiple sepsis measures that were being evaluated. Because of eligibility criteria, not all patient records were eligible for all measures. Therefore, records for IRR were not chosen completely at random; rather, records were selected to maximize the number of measures assessed for IRR at each site.

Results. For the measure numerator, 15 of 300 unique patient records (5%) from the abstraction process were assessed for IRR across the three testing sites. In order for a record to be abstracted for this measure, the patient must meet a specific treatment criterion (lack of previous blood culture at a referring hospital) in addition to the diagnostic criteria (sepsis, severe sepsis, and septic shock). Therefore, IRR was also assessed for these eligibility criteria. For each of these, 15 of 300 unique patient records (5%) from the abstraction process were assessed for IRR across the three testing sites.

Table 4 of the original measure documentation shows the percent agreement and Kappa statistics for the numerator and the eligibility criteria of this measure for each site and across all sites. The overall agreement for blood culture performed elsewhere and sepsis syndrome were both 100% with a corresponding Kappa statistic of 1.00. The overall agreement for timely blood culture was 87% and the Kappa was -0.07. Likewise, the overall agreement for severe sepsis and septic shock were both 87%, with Kappa statistics of 0.72 and 0.58, respectively. Note that the Kappa value is affected by the prevalence of the finding under consideration, similar to positive predictive value being influenced by the prevalence of the condition. For rare findings, very low values of Kappa may not necessarily reflect low rates of overall agreement (Viera & Garrett, 2005).

This time-sensitive measure requires a blood culture to occur within 4 hours of the diagnosis of sepsis syndrome. It was sometimes difficult for abstractors to identify the time at which this event actually occurred. For example, a nurse's note might state that a blood draw occurred at a given time, but the laboratory notes would indicate a different time. Across the 15 medical records compared for IRR, 13 total times were abstracted for the numerator. Overall, 51 total times were abstracted for the diagnosis of sepsis, and 13 times were abstracted for the diagnoses of severe sepsis and septic shock.

Table 5 of the original measure documentation shows the percent agreement and Kappa statistic for assessing whether a blood culture was conducted within 4 hours of a sepsis diagnosis for each site and across all sites. The overall agreement for conducting a blood culture within 4 hours of sepsis diagnosis was 80% with a Kappa statistic of 0.29. In addition, the reliability of determining the time at which key sepsisâ€related events took place was assessed. The overall agreement for identifying the time at which a sepsis diagnosis made (±15 minutes) was 40%. Similarly, the overall agreement for identifying the time at which severe sepsis diagnosis was made (±15 minutes) was 33% and for identifying the time of a septic shock diagnosis (±15 minutes) was 73%. Note that a Kappa statistic cannot be calculated for the time of diagnoses measures since disagreement of times could not be classified appropriately for statistical computation.

Validity
The validity of this measure was determined from two perspectives: face validity and validity of medical record data.

Face Validity. Face validity is the degree to which the measure construct characterizes the concept being assessed. The face validity of this measure was established by a national panel of experts and a parent representative for families of children with sepsis syndrome convened by the Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC). The Q-METRIC panel included nationally recognized experts in the identification and treatment of pediatric sepsis syndrome, representing neonatology, hematology/oncology, infectious diseases, emergency medicine, nursing, pediatric surgery, and pediatric intensive care. In addition, measure validity was considered by experts in state Medicaid program operations, health plan quality measurement, health informatics, and health care quality measurement. In total, the Q-METRIC sepsis panel included 15 experts, providing a comprehensive perspective on sepsis syndrome care and the measurement of quality metrics for states and health plans.

The Q-METRIC expert panel concluded that this measure has a high degree of face validity through a detailed review of concepts and metrics considered to be essential to effective sepsis syndrome identification and treatment. Concepts and draft measures were rated by this group for their relative importance. This measure was very highly rated, receiving an average score of 6.9 (with 9 as the highest possible score).

Validity of Abstracted Data. This measure was tested using medical record data. This source is considered the gold standard for clinical information; our findings indicate that these data have a high degree of face validity. This measure was tested among a total of 274 children younger than 19 years of age with sepsis syndrome (Table 6 of the original measure documentation). Overall, 70% of children with sepsis syndrome had a blood culture drawn within 4 hours of meeting diagnostic criteria for sepsis syndrome (range: 60% to 77%).

Evidence for Extent of Measure Testing

Keyton J, King T, Mabachi N, Manning J, Leonard L, Schill D. Content analysis procedure book. Lawrence (KS): University of Kansas; 2004.

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC). Basic measure information: timely blood culture for children with sepsis syndrome. Ann Arbor (MI): Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium; 2014 Aug. 46 p.

Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. Fam Med. 2005 May;37(5):360-3. PubMed

State of Use of the Measure

State of Use

Current routine use

Current Use

not defined yet

Application of the Measure in its Current Use

Measurement Setting

Emergency Department

Hospital Inpatient

Hospital Outpatient

Professionals Involved in Delivery of Health Services

not defined yet

Least Aggregated Level of Services Delivery Addressed

Individual Clinicians or Public Health Professionals

Statement of Acceptable Minimum Sample Size

Does not apply to this measure

Target Population Age

Age less than 19 years

Target Population Gender

Either male or female

National Strategy for Quality Improvement in Health Care

National Quality Strategy Aim

Better Care

National Quality Strategy Priority

Prevention and Treatment of Leading Causes of Mortality

Institute of Medicine (IOM) National Health Care Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Timeliness

Data Collection for the Measure

Case Finding Period

The measurement year

Denominator Sampling Frame

Patients associated with provider

Denominator (Index) Event or Characteristic

Clinical Condition

Encounter

Institutionalization

Patient/Individual (Consumer) Characteristic

Denominator Time Window

not defined yet

Denominator Inclusions/Exclusions

Inclusions
The eligible population for the denominator is the number of hospitalized children younger than 19 years of age with sepsis syndrome.

Note:

Eligible children are all those admitted to the hospital, including the emergency department (ED).
Intake Period: January 1 through December 31 of the measurement year
Sepsis Syndrome: Sepsis, severe sepsis, and septic shock
International Classification of Diseases, Ninth Revision (ICD-9) codes to identify potential sepsis syndrome cases using administrative data to identify medical records for review are documented in Table 2 of the original measure documentation. Refer to Table 1 of the original measure documentation for additional definitions.

Exclusions

All children with sepsis syndrome who were transferred from another hospital, if the blood culture was performed at the referring hospital
Children who died within 4 hours of meeting diagnostic criteria for sepsis syndrome
Patients with advanced directives for comfort care
Patient or surrogate decision maker declined or is unwilling to consent to therapies

Exclusions/Exceptions

not defined yet

Numerator Inclusions/Exclusions

Inclusions
The eligible population for the numerator is the number of hospitalized children younger than 19 years of age with sepsis syndrome who had a blood culture drawn within 4 hours of meeting diagnostic criteria for this condition.

Exclusions
None

Numerator Search Strategy

Fixed time period or point in time

Data Source

Administrative clinical data

Electronic health/medical record

Type of Health State

Does not apply to this measure

Instruments Used and/or Associated with the Measure

Unspecified

Computation of the Measure

Measure Specifies Disaggregation

Does not apply to this measure

Scoring

Rate/Proportion

Interpretation of Score

Desired value is a higher score

Allowance for Patient or Population Factors

not defined yet

Standard of Comparison

not defined yet

Identifying Information

Original Title

Timely blood culture for children with sepsis syndrome.

Measure Collection Name

Sepsis Measures

Submitter

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC) - Academic Affiliated Research Institute

Developer

Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC) - Academic Affiliated Research Institute

Funding Source(s)

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Composition of the Group that Developed the Measure

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Financial Disclosures/Other Potential Conflicts of Interest

Unspecified

Adaptation

This measure was not adapted from another source.

Date of Most Current Version in NQMC

2014 Aug

Measure Maintenance

Unspecified

Date of Next Anticipated Revision

Unspecified

Measure Status

This is the current release of the measure.

The measure developer reaffirmed the currency of this measure in January 2016.

Measure Availability

Source available from the Quality Measurement, Evaluation, Testing, Review, and Implementation Consortium (Q-METRIC) Web site . Support documents are also available.

For more information, contact Q-METRIC at 300 North Ingalls Street, Room 6C08, SPC 5456, Ann Arbor, MI 48109-5456; Phone: 734-232-0657; Fax: 734-764-2599.

NQMC Status

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The information was reaffirmed by the measure developer on January 7, 2016.

Copyright Statement

Production

Source(s)

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